Spin-Dependent Transport in Magnetic Nanostructures

PI – A. G. Petukhov, South Dakota School of Mines & Technology

DMR AWARD # 0071823

FOCUS

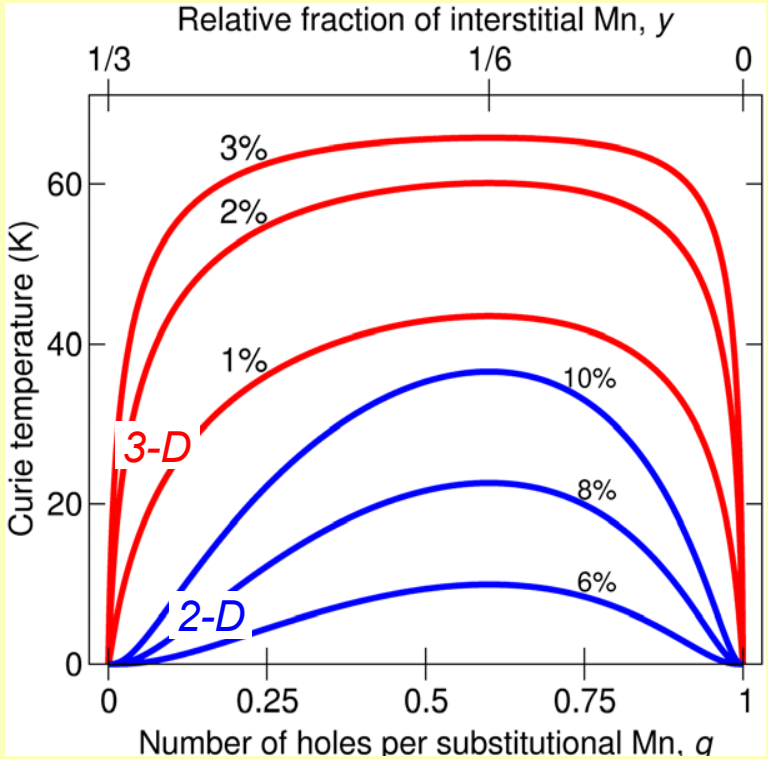
The research focus of our group is theoretical and computational studies of new *materials, structures, and devices* for semiconductor spintronics. Our studies are aimed at the merge of modern semiconductor and magnetic technologies.

FINDINGS

I. Materials.

We developed a new theory of magnetism in dilute magnetic semiconductors such as GaMnAs. Our approach is based on percolation theory and predicts non-monotonic dependence of the Curie temperature on the concentration of interstitial Mn atoms. We provided a theoretical evidence that interstitial Mn is a major source of compensation in GaMnAs. This finding is in agreement with recent experiments by J. Furdyna's group at Pudue University.

Collaboration: ***Steve Erwin, Naval Research Laboratory.***



For all Mn concentrations...

- No compensation $\Rightarrow T_c=0$
- Complete compensation $\Rightarrow T_c=0$
- 0.6 hole/Mn $\Rightarrow T_c$ maximized

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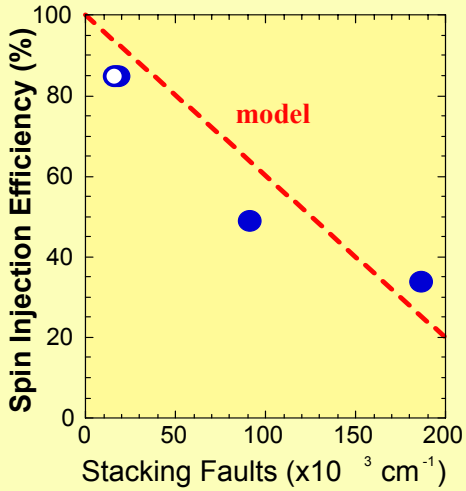
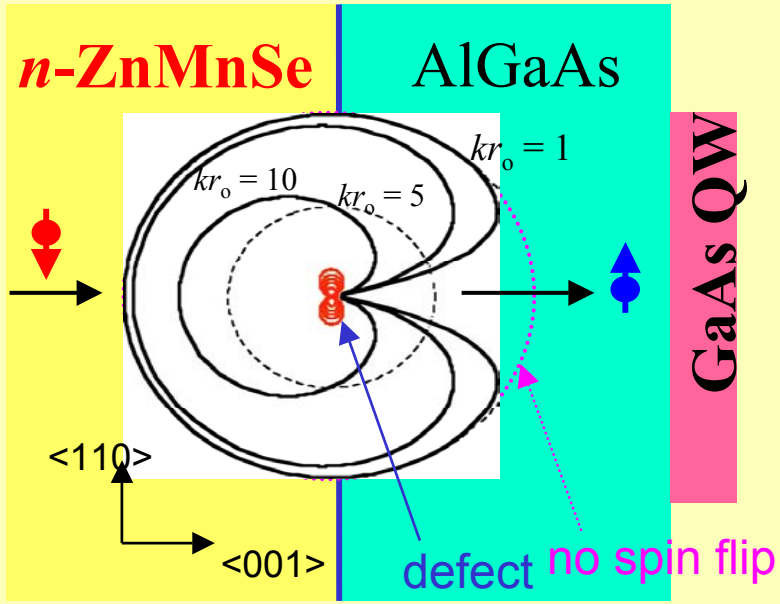


Angular Distribution of Spin Polarization



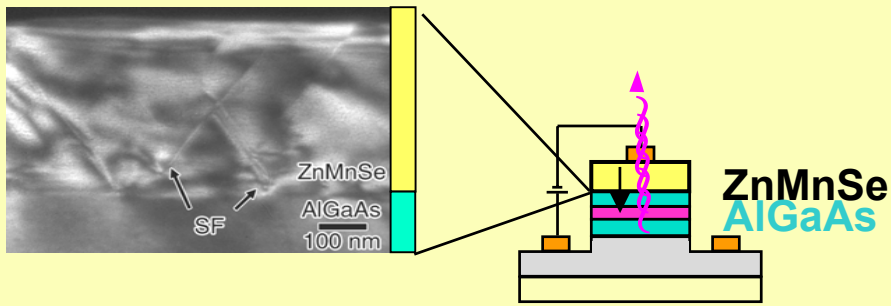
Interface

II. Structures.

We showed that the low symmetry defects such as stacking faults and edge dislocations at the heterointerfaces can drastically reduce spin injection efficiency into a semiconductor due to spin-orbit scattering.

This effect was observed experimentally by Berry Jonker's group at the Naval Research Laboratory.

Collaboration: ***Berry Jonker et al, Naval Research Laboratory.***



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III. Devices

We developed theories of two novel spintronic devices utilizing spin dependent resonant tunneling :

- ***Resonant tunneling spin valve which will enable drastic enhancement of tunneling magnetoresistance (TMR) in semi-conductor tunnel junctions***
- ***Resonant tunneling spin filter – stable source of almost 100% spin-polarized current***

These devices can be used in non-volatile magnetic memories and reprogrammable logics.

OUTREACH

The work would be impossible without undergraduate students Sam French and David Anez and graduate students Denis Demchenko, Athanasios Chantis and Jim Niggemann.